REMARKS

Claims 1, 2, 5-9, 11 and 15-26 are pending in this application. By this Amendment, claims 1 and 11 are amended, claims 3, 4 and 12-14 are canceled and claims 20-26 are added. Support for the amendments may be found, for example, in the specification at page 21, line 10 to page 22, line 4; page 18, line 24 to page 19, line 3; and in the original claims. No new matter is added.

In view of the foregoing amendments and the following remarks, reconsideration and allowance are respectfully requested.

I. Rejections Under 35 U.S.C. §103

A. Claims 1-5, 7-9, 11-15 and 19

The Office Action rejects claims 1-5, 7-9, 11-15 and 19 under 35 U.S.C. §103(a) as having been obvious over U.S. Patent No. 5,942,356 to Mitsui et al. ("Mitsui") in view of JP 2001-303243 to Watanabe et al. ("Watanabe"). By this Amendment, claims 3, 4 and 12-14 are canceled, rendering their rejection moot. As to the remaining claims, Applicant respectfully traverses the rejection.

Claims 1, 8 and 11 require that the sputtering target has (1) a hardness of 900HV or more (claims 1 and 8) or from 900HV to 1400HV (claim 11) and (2) "silicon in an amount from more than 80 mol% to 95 mol%." The asserted combination of Mitsui and Watanabe would not have used such a sputtering target for the following reasons.

Mitsui discloses a method for manufacturing a mask blank by forming a film by reactive sputtering where the silicon content in a sputtering target is 80 mol%. See Mitsui at column 3, lines 45-53; and column 7, lines 25-36. The Office Action acknowledges, at page 3, that Mitsui does not disclose that the sputtering target has a "hardness of 900HV or more." The Office Action asserts, at page 4, that Watanabe discloses the use of a metal silicide target with a hardness of 1300HV or less to produce films without defects because generation of

particles is suppressed from the target. Thus, the Office Action further asserts, at page 4, that one of ordinary skill in the art would be motivated to combine Watanabe and Mitsui because doing so would prevent particle generation from the target and achieve films without defects. Applicant respectfully disagrees.

There is no reason or rationale for one of ordinary skill in the art to combine Mitsui and Watanabe because the two references are directed to producing different films and, thus, disclose different methods of manufacturing film. Mitsui discloses a method of manufacturing a phase shift mask having light semi-transmissive films, which is formed by a reactive sputtering method under an oxygen or nitrogen atmosphere. See Mitsui at column 2, line 64 to column 3, line 53. Watanabe discloses conductive films that are used as electrical wiring, material for forming electrodes or structural elements in semi-conductor devices and liquid crystal display components. See Watanabe at paragraph [0002] (attached herewith is a partial English language translation of Watanabe for the Examiner's convenience). Thus, in contrast to the reactive sputtering method used in Mitsui, the conductive film of Watanabe is formed by sputtering under Ar gas atmosphere, rather than under an oxygen or nitrogen gas atmosphere. As such, one of ordinary skill in the art would have had no reason or rationale to modify the method of Mitsui in view of Watanabe to achieve the claimed method.

Additionally, it would not have been obvious for one of ordinary skill in the art to combine Mitsui and Watanabe to achieve the claimed method because Watanabe discloses a silicon content of 80 mol% or less in the sputtering targets. Specifically, Watanabe discloses a silicon content of 67 to 80 mol% (MSi_x, where x = 2 to 4). See Watanabe at paragraphs [0024]-[0025]. Watanabe further discloses that when the silicon content exceeds 80 mol% the resistance of the film increases, resulting in adverse effects on the components. Id. However, the claimed method and sputtering target requires a silicon content from 80 mol% to 95 mol%. As such, one of ordinary skill in the art would not have modified the method of

Mitsui based on the disclosure of Watanabe, which teaches using a sputtering target having a silicon content of less than 80 mol%, to achieve the claimed method requiring that the sputtering target has a silicon content "from more than 80 mol% to 95 mol%." Instead, if the sputtering target of Watanabe was substituted for the sputtering target of Mitsui, then the modified method would include a sputtering target that contains silicon in an amount less than 80 mol%.

For at least these reasons, Mitsui and Watanabe would not have rendered obvious claims 1, 8 and 11. Claims 2, 5, 7, 9, 15 and 19 depend from claims 1 and 8 and, thus, also would not have been rendered obvious by Mitsui and Watanabe for at least the same reasons. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

B. <u>Claim 6</u>

The Office Action rejects claim 6 under 35 U.S.C. §103(a) as having been obvious over the combination of Mitsui, Watanabe and JP 07-128840 to Okubo et al. ("Okubo I"). Applicant respectfully traverses the rejection.

Claim 6 depends from claim 1 and, thus, contains all of the features of claim 1. The deficiencies of Mitsui and Watanabe with respect to claim 1 are discussed above. Okubo I, which is applied by the Office Action for the additional feature recited in claim 6, does not cure the deficiencies of Mitsui and Watanabe with respect to claim 1 .

Thus, the combination of applied references would not have rendered obvious claim 6. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

C. <u>Claims 17 and 18</u>

The Office Action rejects claims 17 and 18 under 35 U.S.C. §103(a) as having been obvious over the combination of Mitsui, Watanabe and U.S. Patent No. 5,935,735 to Okubo et al. ("Okubo II"). Applicant respectfully traverses the rejection.

Claims 17 and 18 depend from claim 1 and, thus, contain all of the features of claim 1. The deficiencies of Mitsui and Watanabe with respect to claim 1 are discussed above. Okubo II, which is applied by the Office Action for the additional feature recited in claims 17 and 18 does not cure the deficiencies of Mitsui and Watanabe with respect to claim 1 .

Thus, the combination of applied references would not have rendered obvious claims 17 and 18. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

C. Claim 16

The Office Action rejects claims 16 under 35 U.S.C. §103(a) as having been obvious over the combination of Mitsui, Watanabe and U.S. Patent No. 4,938,798 to Chiba et al. ("Chiba"). Applicant respectfully traverses the rejection.

Claim 16 depends from claim 1 and, thus, contains all of the features of claim 1. The deficiencies of Mitsui and Watanabe with respect to claim 1 are discussed above. Chiba, which is applied by the Office Action for the additional feature recited in claim 16, does not cure the deficiencies of Mitsui and Watanabe with respect to claim 1.

Thus, the combination of applied references would not have rendered obvious claim 16. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

II. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1, 2, 5-9, 11 and 15-26 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

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JAO:TTK/emd

Attachments:
- Request for Continued Examination
- Petition for Extension of Time
- Partial Translation of JP 2001-303243

Date: October 16, 2009

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Translation of parts of Watanabe et al. (JP 2001-303243)

[0002]

[BACKGROUND ART]

In electronic components represented by semiconductor devices, liquid-crystal-display components, etc., silicide compounds of high melting point metal, such as W, Mo, Ta, Ti, Zr, and Co, are used as formation materials of electrical wirings or electrodes, components-composing films, etc. Although delay of electrical signals becomes a problem by elongation of electrodes or electrical wirings according to high integration and densification of semiconductor devices, metal silicide thin films containing metal of low resistance, such as W or Mo, are useful as formation materials of electrical wirings or electrodes with low resistance. Metal silicide thin films produce effects of inhibition of electromigration etc.

[0003]

A method for forming the thin film which consists of silicide compounds (WSi2, MoSi2, etc.) of high melting point metals, such as W or Mo, includes a sputtering method and a CVD method as a typical method for forming film, and particularly, the sputtering method is generally used from the point of view of productivity of forming film, stability thereof, a manufacturing cost, etc.

[0015]

[MEANS FOR SOLVING A PROBLEM]

In order to prevent the generation of particles considered to originate in internal structure and internal state of the above-described silicide target, as a result of reviewing various considerations, the present inventors found that the release of internal residual stress of the silicide target at the time of spattering is one of the generation factors of the particles.

[0016]

The present inventors found that the generation of particles based on the release of internal residual stress could substantially be prevented by release of the residual stress of the target beforehand, and furthermore, a release state of this residual stress could be estimated from a hardness of the target. That is to say, it becomes possible that the generation of particles based on the release of the above-described stress is substantially prevented by releasing the residual stress of the silicide target beforehand, and lowering the hardness of the silicide target based on this release of residual stress.

[0017]

Moreover, in processing a target surface, the amount of the generation of particles based on the release of stress can be further reduced by applying a processing method which can reduce residual stress, and thereby putting it into a surface state with small residual stress. Since large irregularities or partial irregularities are one of the generation factors of particles with regard to the target surface (sputtering surface), it becomes possible to reduce the amount of the generation of particles furthermore by reducing such irregularities.

[0018]

The present invention is made based on these findings, and the sputtering target of the present invention, as described in claim 1, is characterized by being constituted of metal silicide expressed as General formula: MSix (M in the formula is at least one of elements selected from W, Mo, Ta, Ti, Zr, Hf, Ni, and Co, and x is a value in the range of 2 - 4), and having a hardness of 1300 Hv or less in Vickers' hardness in sputtering targets having microstructures containing metal silicide phases with chain formation and Si phases formed by bonding of surplus Si particles and discontinuously existing in gaps of the metal silicide phases.

[0024]

The sputtering target of the present invention consists of metal silicide expressed as general formula: MSix. ...(1) (M in the formula is at least one of elements selected from W, Mo, Ta, Ti, Zr, Hf, Ni, and Co, and x is a value in the range of 2 - 4).

[0025]

Here, the value of x is fundamentally set from the amount of Si and the amount of surplus Si constituting MSi2. When the value of x is less than 2, the metal silicide (MSi2) thin film intended cannot be obtained with sufficient reproducibility. On the other hand, when the value of x is more than 4.0, too many amounts of surplus Si cause high resistance, and there is a possibility of having an adverse effect on the components. The value of x is still more preferable to be in the range of 2.5 - 3.2.

[0034]

That is to say, according to the metal silicide target having the hardness of 1300 Hv or less in Vickers' hardness based on a measuring method as mentioned above, it becomes possible to substantially prevent the generation of particles based on the release of stress at the time of the spatter. For further heightening the depression effect of the particles, the hardness of the metal silicide target is preferable to be 1100 Hv or less in Vickers' hardness, furthermore 1000 Hv or less therein.

[0051]

Example 1

...(SKIP)...

[0054]

The W silicide target (127 mm diameter x 6 mm thickness) obtained in such a way was joined to a backing plate made of Cu, and set to a sputtering apparatus. The W silicide film with a thickness of 200nm was formed as a film on a 5 inch Si wafer using such the sputtering apparatus. Sputtering conditions were set to

Ar pressure = 0.2 Pa, Ar flow rate = 80 sccm, and Power = 0.5 kW.

...(SKIP)...

As a result, the number of particles of 0.2 micrometers or more was 5 pieces/sheet.

[0055]

Moreover, W silicide target produced with the same conditions as the above-described manufacturing conditions was prepared, and the hardness of this target was measured by the Vickers' hardness tester (Shimazu microhardness tester: HMV-2000), according to the above described method. As a result, the Vickers' hardness of W silicide target was 950 Hv, and dispersion in the Vickers' hardness as the whole target was 5%.

[0056]

Example 2

...(SKIP)...

[0057]

The W silicide film was formed with the same conditions as example 1using W silicide target (127 mm diameter x 6 mm thickness) obtained in such a way. When the number (average) of particles of 0.2 micrometers or more existing in the W silicide film was investigated, the number of particles of 0.2 micrometers or more was 10 pieces/sheet.

[0058]

...(SKIP)...

As a result, the Vickers' hardness of the W silicide target was 1020 Hv, and dispersion in the Vickers' hardness as the whole target was 10%.

[0059]

Comparative examples 1 and 2

...(SKIP)...

[0060]

...(SKIP)...

As a result, the number of particles of 0.2 micrometers or more was 72 pieces/sheet in comparative example 1, and the number of particles of 0.2 micrometers or more was 60 pieces/sheet in comparative example 2.

[0061]

...(SKIP)...

As a result, the Vickers' hardness of the W silicide target of comparative example 1 was 1490 Hv, and dispersion in the Vickers' hardness as the whole target was 12%. Moreover, the Vickers' hardness of W silicide target of comparative example 2 was 1390 Hv, and dispersion in the Vickers' hardness as the whole target was 25%.

[0062]

Example 3

...(SKIP)...

[0065]

The Mo silicide target (127mm diameter x 6mm thickness) obtained in such a way was joined to a backing plate made of Cu, and then set in the sputtering apparatus. The Mo silicide film with a thickness of 200 nm was formed on the 5 inch Si wafer using such the sputtering apparatus. Sputtering conditions were set to Ar pressure = 0.2 Pa, Ar flow rate = 80 sccm, and Power = 0.5 kW.

...(SKIP)...

As a result, the number of particles of 0.2 micrometers or more was 19 pieces/sheet.

[0066]

...(SKIP)...

As a result, the Vickers' hardness of the Mo silicide target was 1020 Hv, and dispersion in the Vickers' hardness as the whole target was 10%.

[0067]

Example 4

...(SKIP)...

[0068]

The Mo silicide film was formed with the same conditions as example 3 using the Mo silicide target (127mm diameter x 6mm thickness) obtained in such a way. When the number (average) of particles of 0.2 micrometers or more existing in the Mo silicide film was investigated, the number of particles of 0.2 micrometers or more was 14 pieces/sheet.

[0069]

...(SKIP)...

As a result, the Vickers' hardness of the Mo silicide target was 998 Hv, and dispersion in the Vickers' hardness as the whole target was 14%.

[0070]

Comparative examples 3 and 4

...(SKIP)...

[0071]

...(SKIP)...

As a result, the number of particles of 0.2 micrometers or more was 174 pieces/sheet in comparative example 3, and the number of particles of 0.2 micrometers or more was 85 pieces/sheet in comparative example 4.

[0072]

...(SKIP)...

As a result, the Vickers' hardness of the Mo silicide target of comparative example 3 was 1320 Hv, and dispersion in the Vickers' hardness as the whole target was 18%. Moreover, the Vickers' hardness of Mo silicide target of comparative example 4 was 1400

Hv, and dispersion in the Vickers' hardness as the whole target was 25%.

[0073]

Example 5

...(SKIP)...

[0076]

The Ta silicide target (127 mm diameter x 6 mm thickness) obtained in such a way was joined to a backing plate made of Cu and then set in the sputtering apparatus. The Ta silicide film with a thickness of 200nm was formed on a 5 inch Si wafer using such the sputtering apparatus. Sputtering conditions were set to Ar pressure = 0.2 Pa, Ar flow rate = 80 sccm, and Power = 0.5 kW.

...(SKIP)...

As a result, the number of particles of 0.2 micrometers or more was 10 pieces/sheet.

[0077]

...(SKIP)...

As a result, the Vickers' hardness of the Ta silicide target was 1270 Hv, and dispersion in the Vickers' hardness as the whole target was 15%.

[0078]

Example 6

...(SKIP)...

[0079]

The Ta silicide film was formed with the same conditions as example 5 using the Ta silicide target (127 mm diameter x 6 mm thickness) obtained in such a way. When the number (average) of particles of 0.2 micrometers or more existing in the Ta silicide film was investigated, the number of particles of 0.2 micrometers or more was 16 pieces/sheet.

[0080]

...(SKIP)...

As a result, the Vickers' hardness of the Ta silicide target was 1250 Hv, and dispersion in the Vickers' hardness as the whole target was 5%.

[0081]

Comparative examples 5 and 6

...(SKIP)...

[0082]

...(SKIP)...

As a result, the number of particles of 0.2 micrometers or more was 108 pieces/sheet in comparative example 5, and the number of particles of 0.2 micrometers or more was 88 pieces/sheet in comparative example 6.

[0083]

...(SKIP)...

As a result, the Vickers' hardness of the Ta silicide target of comparative example 5 was 1574 Hv, and dispersion in the Vickers' hardness as the whole target was 35%. Moreover, the Vickers' hardness of the Ta silicide target of comparative example 6 was 1500 Hv, and dispersion in the Vickers' hardness as the whole target was 32%.